NORPLOY '82 CRUISE REPORT

AUGUST, 1982

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Cruise Report

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C-CORE

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The Centre for Cold Ocean Resources Engineering (C-CORE) was established at Memorial University of Newfoundland in St. John's in 1975. Its initial funding was provided by the Devonian Group of Charitable Foundations of Calgary. Ongoing funding now comes from government and industry.

The Centre's mandate is to undertake research that will assist the safe and orderly development of Canada's resources in cold and ice frequented oceans.

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SUBMERSIBLE DIVER LOCKOUT 1 (SDL-1)

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CRUISE OBJECTIVE

Sediment stability under the influence of both iceberg interaction and wave and current hydrodynamics is a topic of considerable interest to offshore operators. It must be taken into consideration in the design and emplacement of engineering systems in the waters off Eastern Canada. The purpose of the Norploy '82 cruise was to make direct observations, from the Canadian Armed Forces manned submersible **SDL-1**, of seafloor features, paying particular attention to iceberg scours and sediment stability. Sidescan sonar survey lines and bottom samples were taken to determine and investigate dive sites.

The internal temperatures of icebergs are also of considerable interest as they relate to both the age of the bergs and to their mechanical properties. As very little information is available on temperature of icebergs at any stage of their existence it was hoped that Norploy '82 would provide us with an opportunity to obtain this information as well as data on the size distribution of the bergs.

TABLE 1 CRUISE INFORMATION

Cruise Name and Number:

NORPLOY '82

Vessels

H.M.C.S. CORMORANT

SDL-1

Dates

August 16, 1982 to September 3, 1982

Area

Hamilton Bank, Labrador Shelf

Ships C.O.

H.M.C.S. CORMORANT	Lt. Cmmdr. J. Alexander

Personnel

J.V. Barrie	Senior Scientist, Cruise Coordination
W.T. Collins	Diving/Sidescan/Sampling
D. Diemand	Iceberg Studies
C. Woodworth-Lynas	Iceberg Scour Studies

PLANNED INVESTIGATIONS

1. The main thrust of this cruise was centred around the **SDL-1** submersible. Sidescan Sonar lines were planned, followed by a number of dives to examine specific features of seabed geology, especially iceberg scour marks. Iceberg scour berm morphology and the effects of currents on iceberg scour denudation were to be investigated. We planned to collect bottom samples from the ship, by the use of a Van Veen grab sampler, and from the submersible using a coring device to obtain samples from the troughs of scours (Appendix C).

2. The second phase of the cruise was in relation to our work with iceberg scouring and environmental conditions controlling icebergs. We planned to make remote measurements of temperatures of as many bergs as possible using a precision radiation thermometer (PRT-5). Particular attention was to be paid to recently calved faces. In addition we intended to investigate as many bergs as was feasible by using helicopters to set a party onto the bergs. They would measure the ice temperature profile to a depth of about 6 feet with thermistor probes. In conjunction with this, C-CORE personnel had developed a seismometer package that could be deployed on an iceberg to measure the behaviour during a grounding event.

3. The last goal was in the field of Ice Engineering Research. C-CORE personnel were to gather, from direct observation and

sampling, data on specific energy and acoustic energy attenuation over distance, and also to collect core samples of sea ice and below ice fauna samples.

The original cruise plan was to sail to Jones Sound at 76°N latitude where submersible work and Ice Engineering research were to be carried out. Subsequent submersible operations were also to have been undertaken at Lancaster Sound and Saglek Bank. However, due to logistical problems the cruise did not go any further than 55°N latitude. The submersible operation and the Ice Engineering research program scheduled for north of this latitude were abandoned. The investigations were thus confined to seabed geology and iceberg temperature studies in the area of the Hamilton Bank, Labrador Shelf.

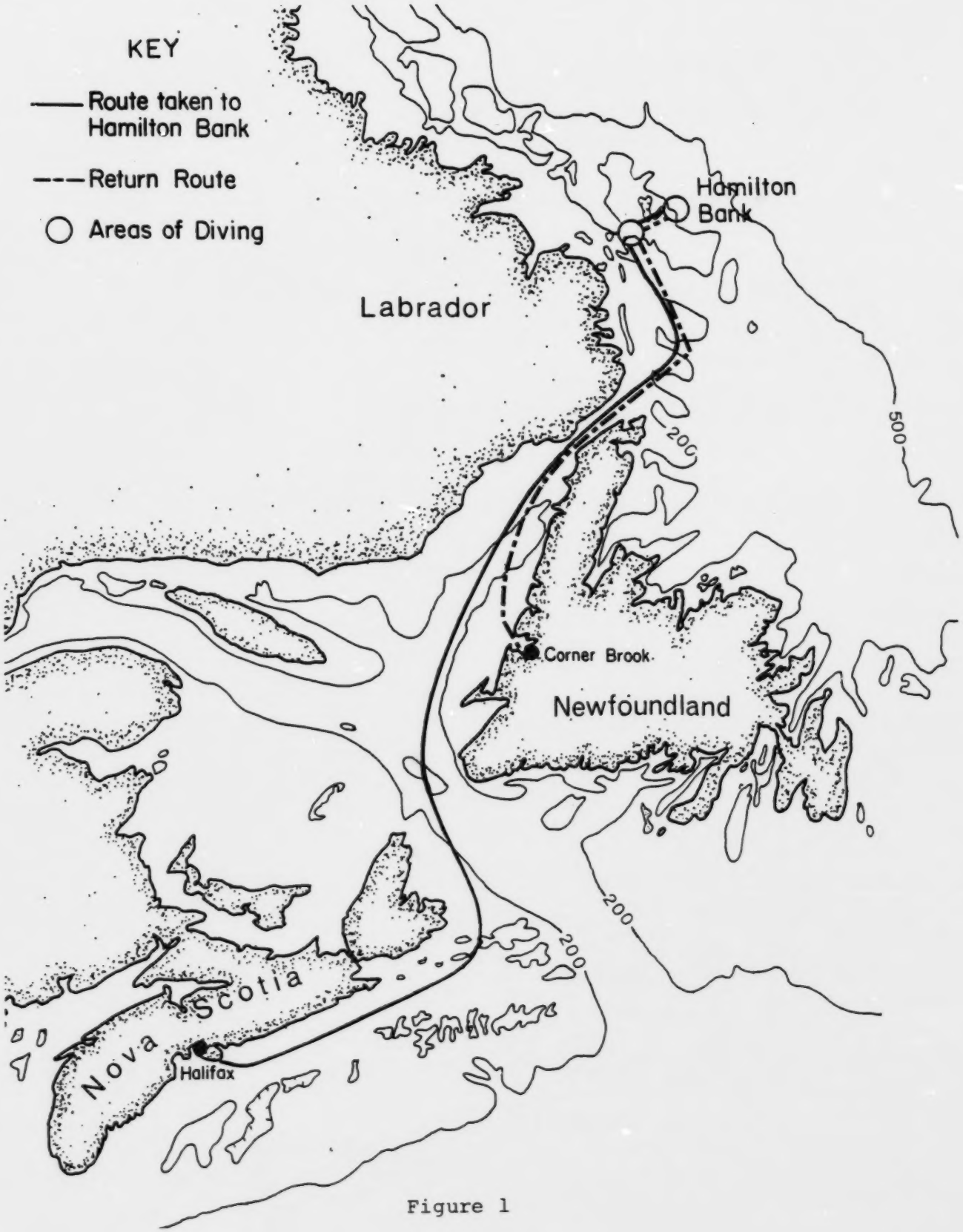
KEY
Route taken to Hamilton Bank
Return Route
Areas of Diving
Hamilton Bank
Labrador
500
200
Corner Brook
Newfoundland
200
Nova Scotia
Halifax

Figure 1

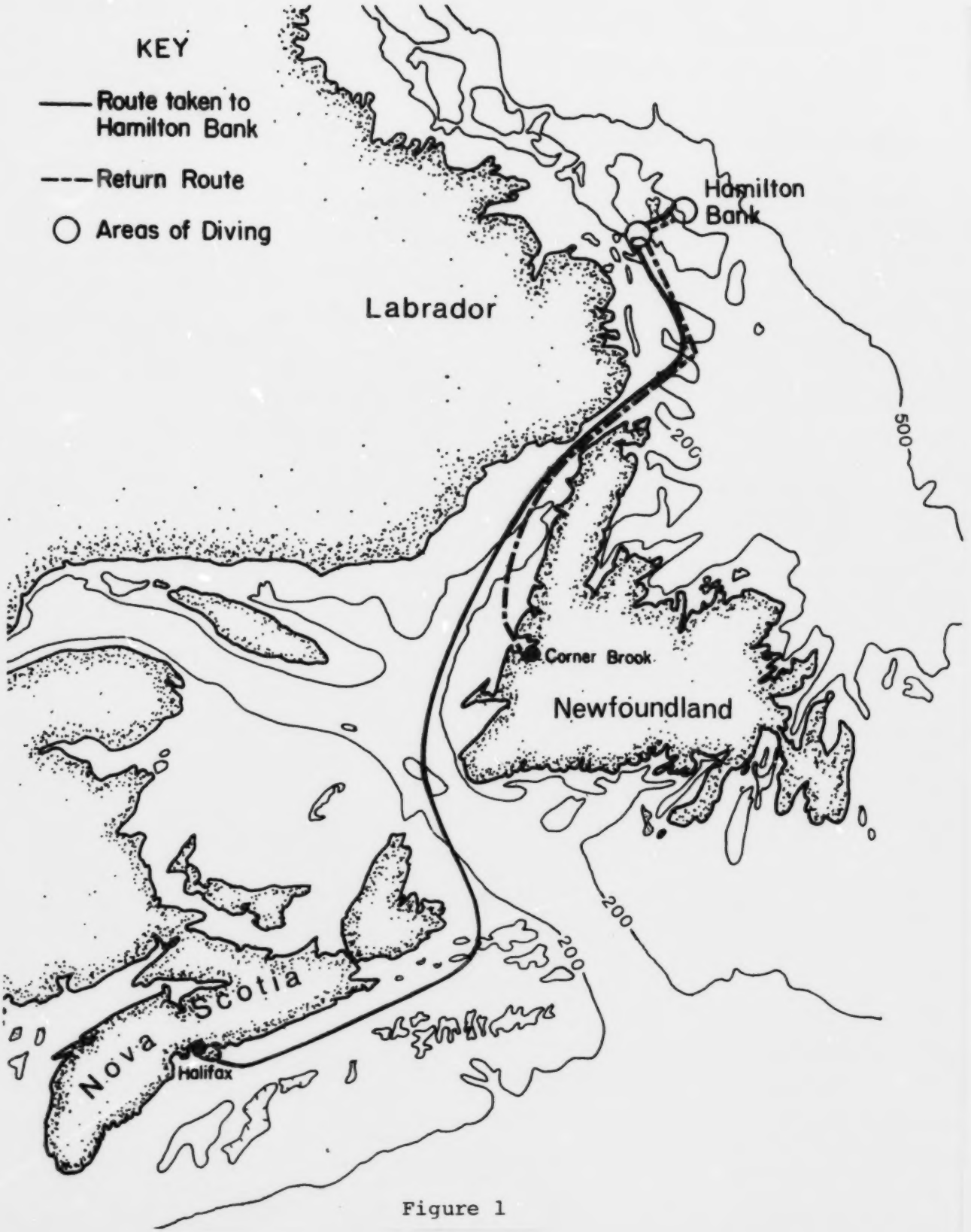
KEY
Route taken to Hamilton Bank
Return Route
Areas of Diving
Hamilton Bank
Labrador
200
500
Corner Brook
Newfoundland
200
200
Nova Scotia
Halifax

Figure 1

CRUISE OUTLINE

Sunday, August 15	Secured and tested equipment aboard the HMCS CORMORANT
Monday, August 15	Sailed from Halifax
Thursday, August 19	Arrived Hamilton Bank, ran sidescan line at site 1, 53° 49.0'N and 55° 32.0'W
Friday, August 20	Completed two dives
Saturday, August 21	Completed one dive
Sunday, August 22	Completed one dive
Monday, August 23	Completed one dive and moved to second area at 54° 32.0'N and 53° 32.00'W
Tuesday, August 24	Completed one dive
Thursday, August 26	Completed two dives
Friday, August 27	Sailed for Corner Brook
Friday, September 3	Arrived at Corner Brook and disembarked the HMCS CORMORANT

TABLE 2

Nature and Quantity of Data

Nature of Data	Quantity of Data
1. Colour Videotape	6 hrs
2. Voice Recording	10 hrs
3. Colour Slides of Seafloor	50
4. Sidescan Sonar	3.6 line km
5. Bottom Samples	11

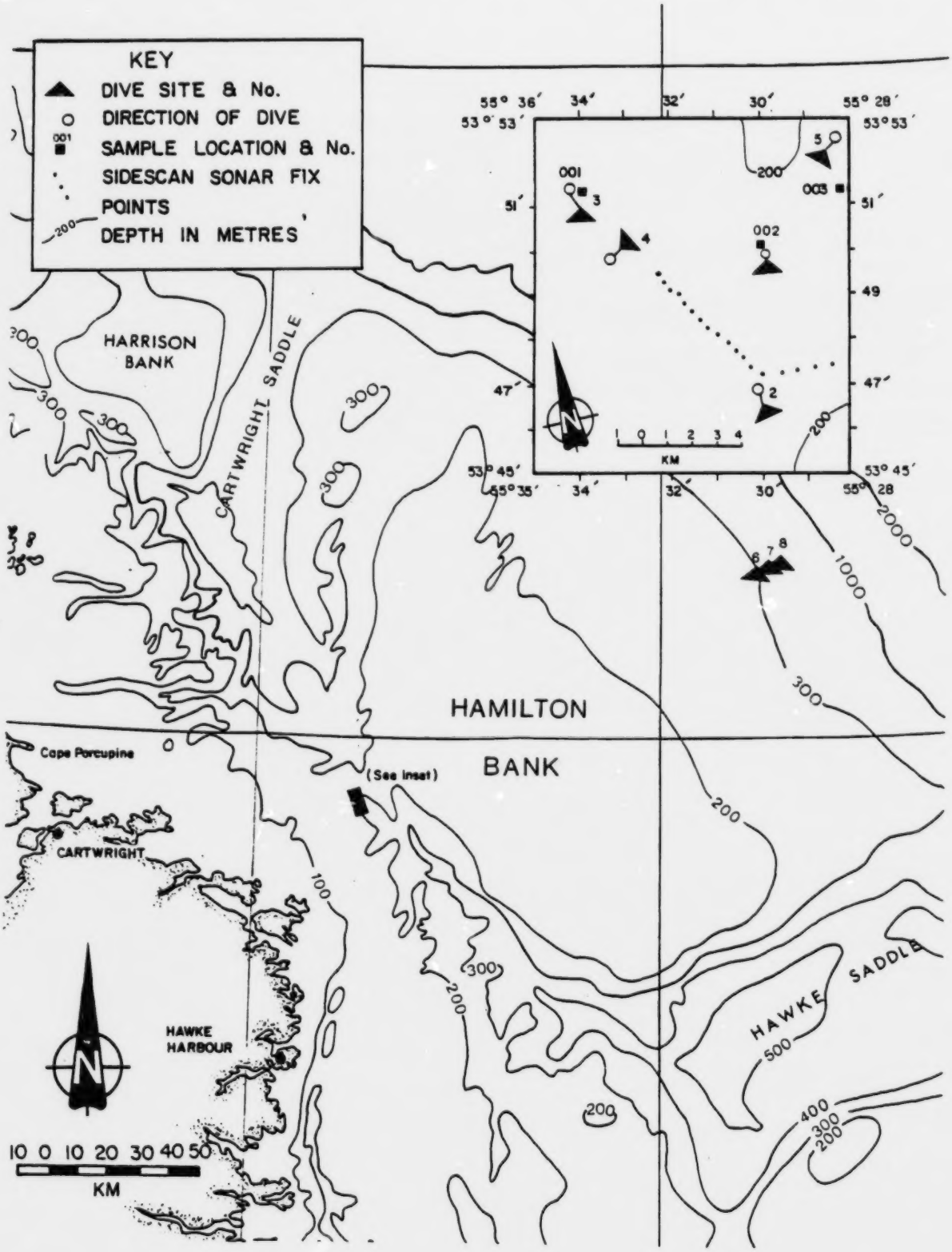
KEY
DIVE SITE & No.
DIRECTION OF DIVE
001 SAMPLE LOCATION & No.
SIDESCAN SONAR FIX POINTS
200 DEPTH IN METRES
HARRISON BANK
CARTWRIGHT SADDLE
HAMILTON BANK
(See Inset)
Cape Porcupine
CARTWRIGHT
HAWKE HARBOUR
HAWKE SADDLE
KM
55° 36′
34′
32′
30′
55° 28′
53° 53′
51′
49
47′
53° 45′
001
002
003
KM

Figure 2

RESULTS

Sidescan

A side scan sonar line was run over a previously acoustically surveyed area (van der Linden and Fillen, 1976) to locate possible targets for diving observations. Approximately 3.6 line km of sidescan sonar was run using an EG and G fish and recorder. Conditions were ideal with a low sea state and light winds. Electrical difficulties occurred at the outset and the problem was traced to the cable. After substitution of the cable the line was run (Fig. 2) at a ship's speed of 2.4 knots. For 90% of the line the scale was set for a total swath width of 400m. The record was fair to poor with gain control problems on the port channel. Fix positions were set at five minute intervals using SATNAV (Appendix B). No thermocline problems were observed but fish motion was encountered. The average water depth ranged between 180 and 200 m.

Submersible Work

The diving was carried out using the **SUBMERSIBLE DIVER LOCKOUT 1** (SDL-1) of the Canadian Armed Forces. The **SDL-1** is untethered and capable of carrying five people to a depth of 610 metres. It is limited to conditions of less than Beaufort sea state 5, with winds up to 30 knots. The submersible is capable of a maximum speed of 2 knots; it is, therefore, limited to areas where currents are less than this. The vehicle has both a forward command sphere and an after sphere, linked by a tunnel. The command sphere has seven forward looking portholes which provide a

wide field of view. Underwater visability was limited; the submersible could light approximately 10 metres of sea floor. The submersible has two different, remotely operated, moveable arms to which various sampling devices can be attached (Appendix C). Using a Panasonic WV-3600 Series colour video camera, mounted inside the submersible, with a video casette recorder and a 5" colour monitor, C-CORE personnel were able to record videotape while traversing the bottom. Also an Olympus OM-1 35 mm camera fitted with a databack was used to take still pictures of the seafloor. The submersible is equipped with a forward looking sonar which can range up to 490 metres.

Diving was carried out in two areas on the Hamilton Bank, Labrador. The first dive site was on the western edge of the bank where a survey had been carried out during the **CSS HUDSON** Cruise 79-019. Dive sites 2 to 4 were chosen from targets identified on the sidescan line. Dive 5 was chosen to fill in between the two survey areas and to explore the seafloor further east (Fig. 2). From previous work an area to the east on the seaward edge of the Hamilton Bank showed features thought to be an ancient strandline (H. Josenhans per. comm). Dives 6 to 8 concentrated on the exploration of this feature.

Iceberg Research

The primary objective of the iceberg research project on Norploy '82 was to measure the temperatures of icebergs encountered along the route past Labrador and Baffin Island. The secondary objective was to determine the sizes, weights and shapes of all bergs which could be seen on the cruise. Attempts were made to measure the above water dimensions of bergs at distances of 5 miles and greater using a sextant. The distance could be measured very accurately using the ship's radar but the sextant readings were not felt to be sufficiently precise for an accurate calculation of berg size. This was due to the ship's motion and the very small angular dimensions of the bergs at greater than about 5 miles. All 3 bergs were roughly 1,000,000 tonnes. The first was a 3-peaked dry dock berg which broke up the following day. The PRT temperature readings at various locations on its surface gave figures ranging from about 0°C, on a craggy face containing a 3 feet wide refrozen blue crack, to a low of about -4°C measured at the waterline in several places where the ice was being washed by waves.

A screwdriver was driven into a nearly vertical face of the berg in an attempt to insert a thermistor. A few hammer strokes produced an ominous cracking sound and a spider web of cracks extending about 20 feet from the screwdriver hole. Prudence dictated that the mission be abandoned.

The second berg was slightly larger than the first and appeared more stable. PRT readings along the waterline were again in the order of -4°C. A minimum temperature of -7°C, however, was

measured on a shaded face about 20 - 30 feet above the water line; the same peak on the sunny side measured -5 to -6°.

Investigation of the berg itself was not attempted; however, we did try to drive a hole into a growler which appeared to have recently separated from the berg. We hoped to obtain its internal temperature using the thermistor probe, however the sea was too rough to accomplish this.

Unfortunately, the rough seas also damaged the PRT so that it could not be used to measure the temperature of the third berg we encountered. Attempts were made to chop fairly large fragments off nearby growlers but we were unable to do this, again due to sea state. Also we were prevented from obtaining any thermistor readings using screw driver holes in the growlers.

In all our attempts to break or penetrate the bergs and growlers we noticed that there was a strong tendancy for the ice to break off in plates. This suggested the presence of considerable stresses running parallel to the internal isotherms of the ice.

The data obtained, are not numerous, but suggest that icebergs are considerably colder than 0°C even as far south as 54°N to 55°N in late August, and that there is considerable individual variation between them. This variation could be the result of a number of factors:

i) original temperatures (ie. bulk temperatures at time of calving from the parent glacier),

ii) time spent in Baffin Bay (ie. in very cold water with minimum ablation),

iii) time spent in the Labrador Sea (ie. in water in which ablation will take place),

iv) the amount of calving which had taken place a short time before the readings were taken and

v) the amount of rolling the berg had recently done.

Other factors could, of course, be involved but more work will be required before a better idea of the interaction of these factors can be formed.

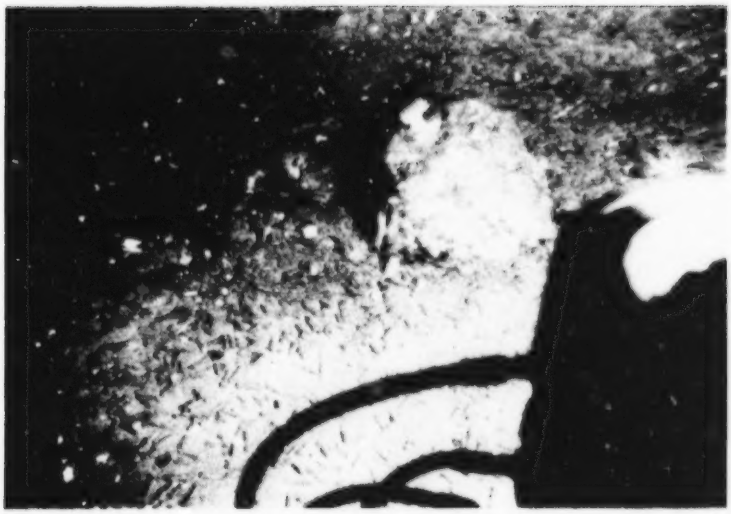

Figure 3 Polychaete worm tubes

SCIENTIFIC FINDINGS

1. The fair to poor quality of the sidescan made it difficult to identify specific targets seen on the earlier acoustic survey of Hamilton Bank (van der Linden and Fillon, 1976). From the sonar line two possible iceberg scours were detected. The most prominent feature measured at least 1.5 km in length and approximately 25 m in width.

2. From the Van Veen Grab samples acquired (Fig. 2) it was noted that the surficial sediment in this area on the Hamilton Bank consisted of buff to brown coloured silt and sand with minor amounts of gravel. A small fraction of organic debris consisting of shell fragments was observed. The sediments recovered correlate with the Groswater Unit of van der Linden and Fillon, (1976).

3. Dives 1 - 5, (Fig.2, p. 10) occurred on the western edge of the Hamilton Bank where water depths ranged between 180 and 215 m. The area was covered by a thin veneer of fine sediment. On the bottom polychaete worm tubes with random orientation were found in a patchy distribution (Fig. 3). Below these and making up the bulk of the sediment observed, was silt and sand, generally unconsolidated in the first 10 - 15 cm. This was followed by a layer of unknown thickness which consisted of overconsolidated sediments which could not be sampled. Gravel patches were distributed along with the silt and sand, throughout the area.

These gravel areas were ovate to linear. The length was generally at least twice as long as the width which ranged from 5 to 10 m. Boulders ranging from 500 cm to 1 m in diameter were observed scattered randomly over the seafloor. Ridge and trough structures interpreted as iceberg scours, consisted of parallel ridges ranging up to 2 m in height. In one case, two troughs converged and formed intersecting scours.

4. The second series of dives took place on the east central part of the Hamilton Bank where water depths ranged between 300 and 400 m (Fig. 2). This area had a high percentage of gravel forming an undulating seabed. Fine sediment was concentrated in the depressions betweem the gravel areas. The gravel formed linear features up to 2 m in width, with spacing between the features of up to 30 m. They were oriented parallel to the bank edge (Fig.4).

5. During submersible operations, observations of ice scour berm morphology were made. On a large scale the scours consisted of parallel ridges up to 2 m in height above the seabed. On a traverse across a single scour berm from the outside towards the centre of the scour the sediments ranged from partially buried boulders, 30 cm in diameter, in a poorly sorted matrix of silt, sand and gravel on the outer berm flank, to well sorted gravel and sand toward the crest. On the crest little fine material was observed. The inside slope of the berm consisted of moderately well sorted sand and gravel. On the inside berm flank there were fewer large boulders than on the outer flanks. The boulders,

Figure 4 Linear gravel features with orientation parallel to bank edge

however, appeared to be resting on the substrate rather than in it as seen at the outer flank of the berm.

6. Large boulders, from 500 cm to 2 m in diameter were observed throughout the survey areas. The boulders were larger in deeper waters. Some were partly buried in the substrate though the majority of the boulders were resting on the seabed. The boulder-sediment interface was observed. With the boulders sitting on the substrate, the fine sediment was seen either onlapping against the boulder or apparently winnowed away forming an apron of gravel surrounding the boulder (Fig.5). The sediment may have been removed by the action of the currents or by benthic organisms which take refuge under some of the large boulders. The boulders which could be identified were crystalline in lithology; for example one was a gneiss.

Figure 5 Apron of gravel surrounding boulder

7. Our findings, in agreement with the scant existing measurements of iceberg temperatures, suggest that the bulk temperatures of bergs along the coast of Labrador are considerably colder than commonly believed. A small change in temperature of ice near its melting point causes a large change in the physical and mechanical properties of the ice. Further work in this area is needed to provide a useful data base which designers of seabed installation and similar structures can use.

REFERENCE

van der Linden, W.J. and Fillon, R.H. 1976. Hamilton Bank, Labrador Margin: origin and evolution of a glaciated shelf. Marine Sciences paper 14 and Geological Survey of Canada paper, 75-40.

APPENDIX A

Diving Information

Dive Number: SDL82-1

Position: 53 48.73 N 55 29.85 W

Date: August 20, 1982

Weather: winds light and variable, low seastate

Equipment: - voice recording
- 35 mm camera
- corer and sediment grab

Hatch Closed: 1108 hrs GMT
Hatch Open: 1432 hrs GMT
Total Time: 3 hrs 24 min.
Max. Depth: 209 m

Personnel from C-CORE: W. Collins
D. Diemand

Samples: SDL82-001
SDL82-002

Dive Number: SDL82-2

Position: 53 46.9 N 55 30.26 W

Date: August 20, 1982

Weather: Winds light and variable, low sea state, rain

Equipment: - voice recording
- 35 mm camera
- corer and sediment grab

Hatch Closed: 1612 hrs. GMT
Hatch Open: 1912 hrs. GMT
Total Time: 3 hrs.
Max. Depth: 212 m

Personnel from C-CORE: W. Collins
D. Diemand

Samples: SDL82-003

Dive Number: SDL82-3

Position: 53 51.0 N 55 34.0 W

Date: August 21, 1982

Weather: Light winds and low sea state

Equipment: video camera with audio
voice recorder
35 mm camera

Hatch closed: 1100 hrs GMT
Hatch open: 1349 hrs GMT
Total Time: 2 hrs 49 min
Max. Depth 189 m

Personnel from C-CORE: W. Collins
D. Diemand

Samples: None

Dive Number: SDL82-4

Position: 53 50.14 N 55 33.07 W

Date: August 23, 1982

Weather: low winds, low sea state

Equipment: - video camera without audio
- voice recorder
- 35 mm camera
- sediment grab

Hatch Closed: 1955 hrs GMT
Hatch Open: 2256 hrs GMT
Total Time: 3 hrs 1 min
Max. Depth: 198 m

Personnel from C-CORE: W. Collins
D. Diemand

Samples: SDL82-004

Dive Number: SDL82-5

Position: 53 52.2 N 55 28.5 W

Date: August 24, 1982

Weather: low winds, low seastate

Equipment: - video camera with audio
- voice recorder
- 35 mm camera
- sediment grab

Hatch Closed: 1330 hrs GMT
Hatch Open: 1625 hrs GMT
Total Time: 2 hrs 55 min
Max. Depth 212 m

Personnel from C-CORE: W. Collins

Samples: None:

Dive Number: SDL82-6

Position: 54 32.93 N 53 32.14 W

Date: August 25, 1982

Weather: Moderate winds, moderate seastate, overcast with rain showers

Equipment: - video camera with audio
- voice recorder
- 35 mm camera
- sediment grab

Hatch Closed: 1108 hrs. GMT
Hatch Open: 1500 hrs. GMT
Total Time: 3 hrs 52 min
Max. Depth: 316 m

Personnel from C-CORE: W. Collins

Samples: None

Dive Number: SDL82-7

Position: 54 33.90 N 53 29.09 W

Date: August 27, 1982

Weather: Moderate wind and seastate, high overcast

Equipment: - video camera with audio
- voice recorder
- 35 mm camera
- sediment grab

Hatch Closed: 1120 hrs GMT
Hatch Open: 1510 hrs GMT
Total Time: 3 hrs 50 min
Max. Depth: 344 m

Personnel from C-CORE: W. Collins

Samples: SDL82-005
SDL82-006
SDL82-007

Dive Number: SDL82-8

Position: 54 32.75 N 53 28.00 W

Date: August 27, 1982

Weather: low winds and seastate

Equipment: - video camera with audio
- voice recorder
- 35 mm camera
- sediment grab

Hatch Closed: 1715 hrs GMT
Hatch Open: 1920 hrs GMT
Total Time: 2 hrs 5 min
Max. Depth: 375 m

Personnel from C-CORE: W. Collins

Samples: SDL82-008

Comments: Dive aborted due to electrical difficulties

Appendix B

Sidescan Sonar Log

Event	Time (hrs:min)	Lat.	Long.	Depth (metres)	Comments
0	0	53 49.5	55 32.25	-	Start line
*0a		53 49.3	55 33.07	-	Aprox. position of first scour
1	00:10	53 49:17	55 32.98	174	
2	00:15	53 48.98	55 32.82	177	
3	00:20	53 48.80	55 32.70	190	
4	00:25	53 48.59	55 32.55	1	
5	00:30	53 48.41	55 32.41	-	
6	00:36	53 48.22	55 32.26	182	
7	00:40	53 48.07	55 32.16	-	At this point we received an up-dated position from SatNav.
8	00:45	53 47.91	55 30.74	-	
9	00:50	53 47.71	55 30.56	192	
10	00:55	53 47.52	55 30.39	-	
11	01:00	53 47.34	55 30.22	188	Starting to turn to port here
12	01:05	53 47.16	55 30.03	-	Finish turn
13	01:10	53 47.18	55 29.53	-	Scale change from 200-125 m
14	01:15	53 47.25	55 29.15	-	
15	01:20	53 47.31	55 28.80	-	
16	01:25	53 47.38	55 28.48	194	

*Note: Due to a tracking error, events 0a to 7 should show a decrease in Longitude of one minute.

Figure 6 Sample Collection Devices: A) Core sampler and B) Surficial Sediment Catcher (scale - 1 metre)

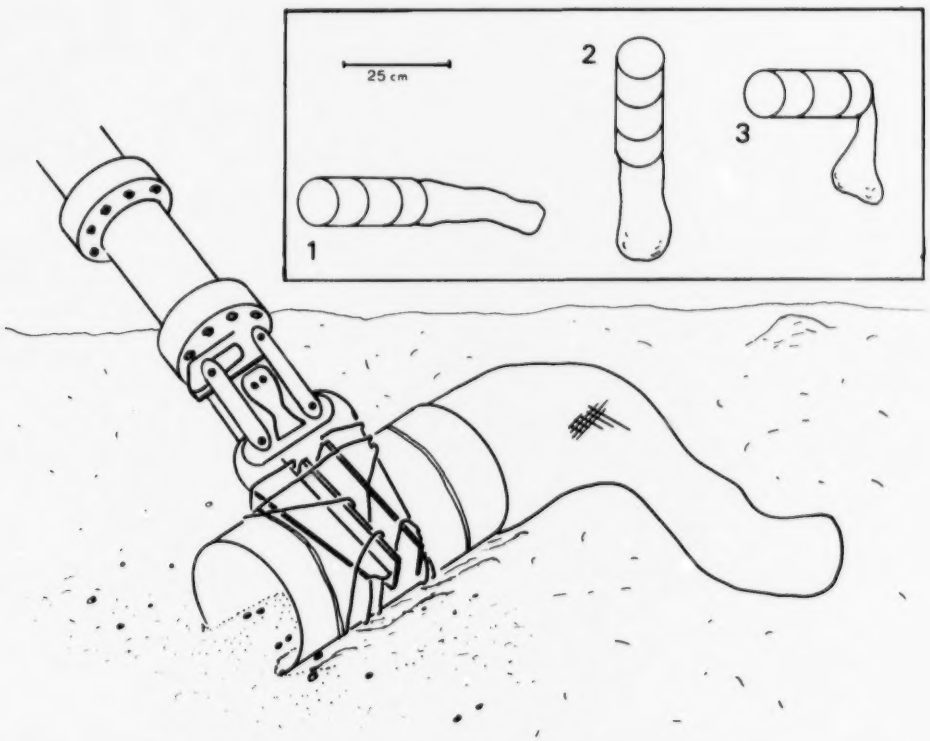

Figure 7 The Cylindrical Sampler. Insert shows the Cylindrical Sampler: 1 - in sampling position, 2 - transferring the sediment to the catch bag and 3 - returning to the horizontal position and retaining the sample

APPENDIX C

Sampling Devices

Three devices were used for the recovery of sediment from the seafloor. In order to get a complete sample from strata below the surface C-CORE personnel used the remote manipulator arm on the submersible and tried to push a core barrel into the sediment (Fig.6A). This technique proved useless as the submersible could not supply sufficient force to drive the barrel into the sediment. Another method which proved to be a little more successful was to use a stainless steel hoop with a catch bag attached (Fig. 6B). This was pushed across the bottom and could retrieve a surficial sediment sample. The third and most successful method employed a device made with materials abroad the ship. This Cylindrical Sampler (Fig. 7), consisted of a sheet metal cylinder, open at one end with a tubular catch bag at the other end. When this device was in the sampling position both the cylinder and bag were in a horizontal position. This allowed the cylinder to scoop up the sediment and transfer it to the bag. If the cylinder was then lifted off the bottom, the catch bag with the sediment fell to the vertical position, the entrance to the bag was cut off and the sample was retained. It is possible to fit two of these devices onto the PHA manipulator arm of the submersible. This device allowed better control of the sample location as well as better retention of the sample.

APPENDIX D

Sample Log

Sample Number	Location	Depth (metres)	Recovery Method	Description
COR 82-001	53°51.03'N 53°34.02'W	670	Van Veen	Brown sand and mud, minor benthic material
COR 82-002	53°50.02'N 55°03.05'W	670	Van Veen	Black Pebble
COR 82-003	53°51.50'N 55°28.22'W	675	Van Veen	Small amount of sand and silt
SDL 82-001	53°48.73'N 55°29.85'W	670	Submersible	Small cobble black in colour
SDL 82-002	53°48.73'N 55°29.85'W	670	Submersible	Small cobble gneiss
SDL 82-003	53°46.05'N 55°30.00'W	640	Submersible	Small cobble
SDL 82-004	53°50.14'N 55°33.07'W	650	Submersible	Sponge
SDL 82-005	53°33.90'N 53°29.09'W	1130	Submersible	Buff coloured sand with minor amounts of benthic material
SDL 82-006	53°33.90'N 53°29.09'W	1130	Submersible	Buff coloured silt and sand (sample taken from a much more sandy area)
SDL 82-007	53°33.90'N 53°29.09'W	1130	Submersible	Silt and sand
SDL 82-008	54°32.75'N 53°28.00'W	1230	Submersible	Granules, silt sand and shell debris

Note: Samples prefixed by COR were those retrieved by ship board sampling and samples prefixed by SDL were those retrieved by the submersible.